MSW Landfill Bioreactor Research

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Presentation Content

- Working Definition
- Benefits and Challenges
- Description of Bioreactor Research

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What is a Bioreactor?

- A landfill designed and operated in a controlled manner with the express purpose of accelerating the degradation of MSW inside a landfill containment system

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Bioreactor Status

- ORD has been cooperatively investigating aspects of bioreactor landfills for 20 years
- Landfill bioreactors are operating today
- Field performance data is scarce
- Potential benefits are significant

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Bioreactor Fundamentals

- In simplest form, leachate reintroduced to the waste mass
- In more complex forms, sequenced addition of liquids, air or other combinations performed with aim of optimum degradation

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Bioreactors – Potential Benefits

- Bioreactors produce the same amount of methane, but at a faster rate
- Bioreactors act as on-site leachate pre-treatment systems
- Bioreactors produce less potent leachate
- Bioreactors require relatively few physical modifications compared to traditional landfills
- Landfills with substandard liquids management can become physically unstable
- Bioreactor techniques may be applicable to landfill corrective actions.

Bioreactors – Research Challenges

- Which bioreactor operational techniques most efficiently degrade waste?
- How can operators distribute leachate and collect gas efficiently in a bioreactor setting?
- How can an interim cover be applied to a waste mass that is settling?
- How do operators ensure physical stability?
- How much moisture addition is optimal for degradation?
- What limitations exist for natural degradation ?
- When can the landfill be “switched off” and close?
- How can operators learn to control their bioreactor?

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Planned ORD Bioreactor Research Outputs

- Report on existing bioreactor data and research needs (FY01 – in clearance)
- Microbiology paper at Sardinia Conference (FY01)
- Conference paper(s) (FY02)
- Interim field assessment of a bioreactor system (FY03)
- Report/fact sheet for guidance on landfill gas evaluation (FY03)
- Microbial assessment of landfill bioreactor operations (FY04)
- Interim bioreactor design manual (FY06)
- Bioreactor design and monitoring manual (FY08)

ORD Bioreactor Research

- Bioreactor CRADA
  - » Cooperative Research and Development Agreement with Waste Management Inc.
    - — Share tasks information
    - — Technical Consultation
    - — Signed in 2000 designed to end in 2005
- Research Projects
  - » State-of-the-Practice of Bioreactor Landfills
  - » Microbial Temporal Analysis of Waste Degradation

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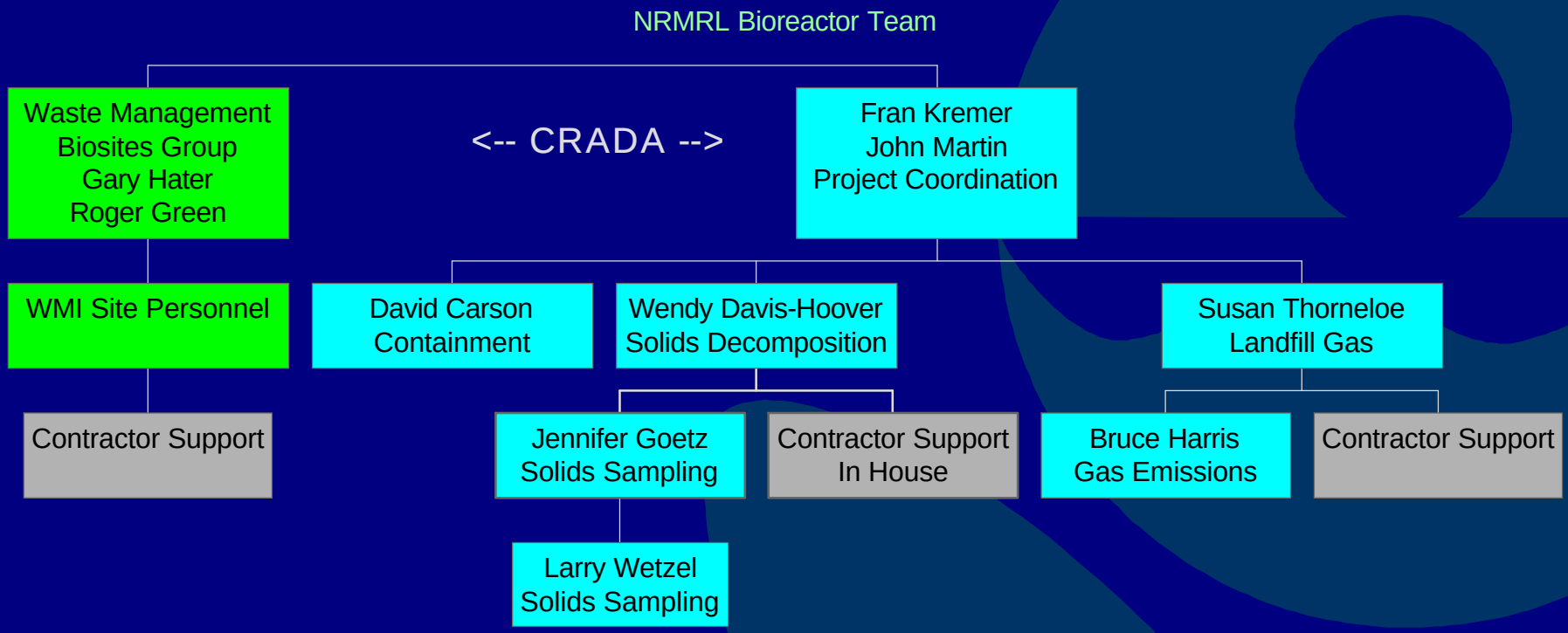
CRADA Project Objectives

- To determine the parameters and trends that should be monitored to assess the performance of and control a bioreactor landfill.
  - Leachate
  - Gas Management/Fugitive Emissions
  - Solids Decomposition
- Two primary sites
  - Area 7 – New fill
  - Area 5 – Existing fill to be retrofitted, and will use nitirified leachate to control ammonia levels
  - Shared experimental control area

CRADA Bioreactor Research Team



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Outer Loop Landfill

- Located near Louisville, KY
- 60+ acres in size
- Cooperative and knowledgeable staff
- Cooperative state regulators
- High ground water table, interceptors in place
- Near airport
- Room for experimentation

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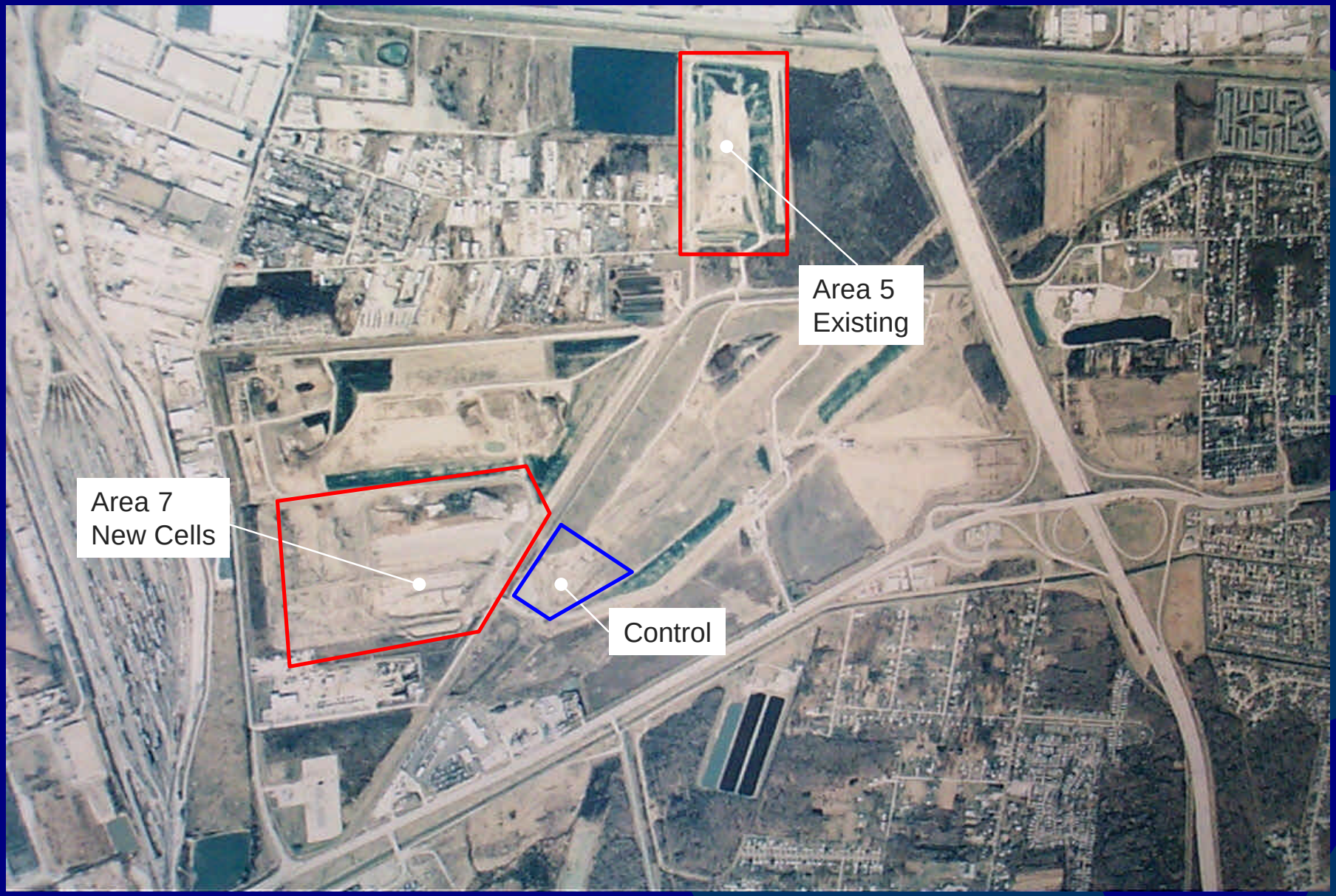

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Leachate Measurements

Critical	Non Critical
COD (Chemical Oxygen Demand)	VOC (Volatile Organic Compounds)
BOD (Biological Oxygen Demand)	SVOC (Semi-Volatile Organic Compounds)
Temperature	Ortho-phosphate
pH (in field)	Total phosphorous
VOA	Total Kjeldahl nitrogen
	Total dissolved solids
	Sulfate
	Chloride
	Potassium
	Conductance
	RCRA Hazardous Metals
	Ammonia Nitrogen
	Nitrate Nitrogen
	Nitrite Nitrogen
	Liquid Head on Liner
	pH (laboratory)
	Leachate production

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Source: CRADA Quality Assurance Project Plan Final 21 SEP 2001

Waste Solids Measurements

Critical	Non-Critical
Waste Temperature	Oxidation-Reduction Potential (ORP)
Waste Settlement (by GPS)	Cellulose-Lignin Ratio
Organic Solids	Appearance of Waste (e.g color, texture, type)
Moisture Content	
pH	
Biochemical Methane Potential (BMP)	
Waste Density	

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Source: CRADA Quality Assurance Project Plan Final 21 SEP 2001

Gas Measurements

Critical	Non-Critical
Methane	Surface Emissions
Carbon Dioxide	Non-methane Organic Compounds (NMOC)
Oxygen	Hazardous Air Pollutants (HAPs)
Gas Volume	

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Source: CRADA Quality Assurance Project Plan Final 21 SEP 2001

Microbial and Biochemical Measurements of Extracts from Solids

Enumeration Aerobic	Nitrate/Nitrite
Enumeration Anaerobic	Ammonia
Enumeration Sulfate Reducers	Total Kjeldahl Nitrogen
Enumeration Denitrifiers	Methane
Enumeration Methanogens	Dry Weight
Volatile Fatty Acid	Antimony, Arsenic, Barium, Cadmium, Chromium,Cobalt, Copper, Iron, Lead
Mercury, Silver, Thallium	Nickel, Selenium, Sodium, Vanadium, Zinc, Potassium, Manganese, Magnesium, Calcium

Source: CRADA Quality Assurance Project Plan, Addendum for Microbial Studies, QAID 302-Q3-2, 29 June 2001

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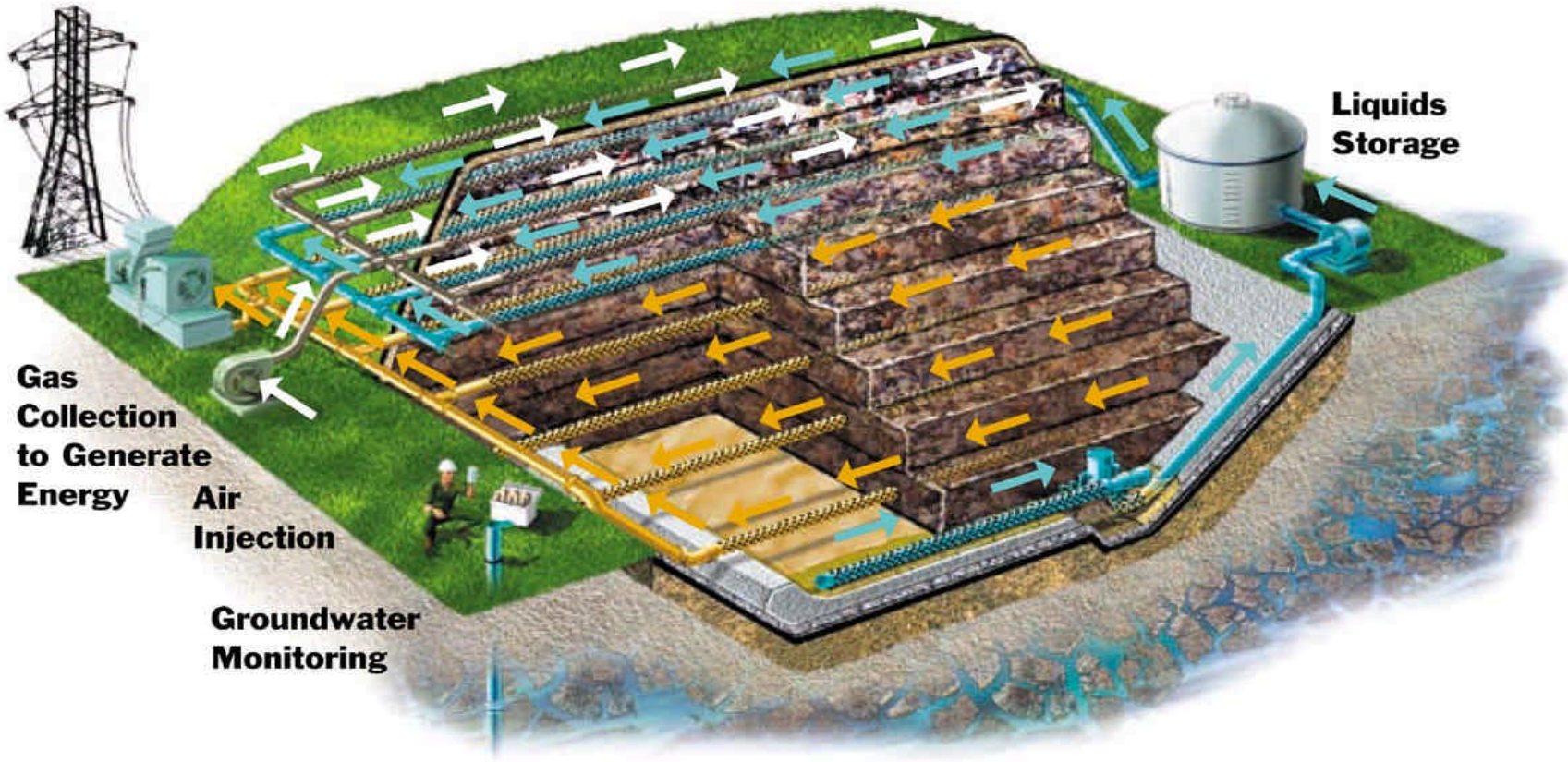
Aerobic-Anaerobic Bioreactor



Leachate / Liquids Addition
Gas Collection
Air Injection

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Bioreactor Program

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Area 7
New Bioreactor

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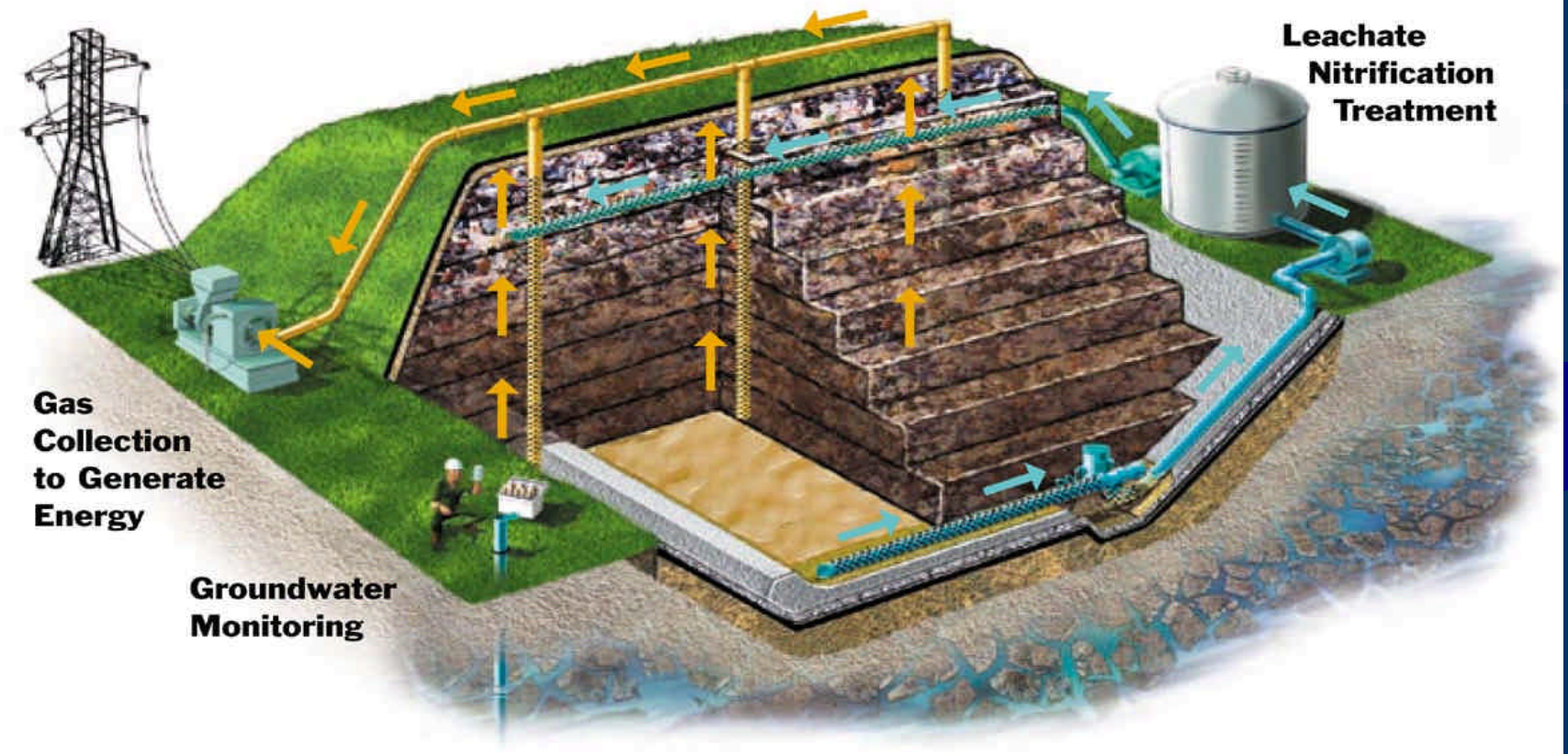
Facultative Bioreactor



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